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Proposed Curriculum and Syllabus on Disease Vector Management in Water Resources Development Projects for Inclusion in Engineering Courses.

Following an informal consultation at
Silsoe College, Bedford, UK from
1st-5th September 1986.

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Proposed Curriculum and Syllabus on Disease Vector Management in Water Resources Development Projects for Inclusion in Engineering Courses.

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List of Abbreviations Used in the Text

EM	Environmental Management
VBD	Vector Borne Disease
WHO	World Health Organization
WRDP(s)	Water Resource Development Project(s)

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Silsoe College/WHO
1-5 September 1986
at Silsoe College, Silsoe, Bedford, MK45 4DT, U.K.

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Preface

At the request of the Division of Vector Biology and Control, WHO, an informal consultation was held at Silsoe College, UK, during 1-5 September 1986. The purpose of the meeting was to develop a curriculum and guidelines for a syllabus for the inclusion of disease vector management in relation to water resource development projects (WRDPs) in engineering courses*. Participants in the meeting came from Bulgaria, UK, USA, USSR and WHO Geneva.

A series of background papers was presented by the participants following which detailed discussions took place. A visit was also made to Hydraulics Research Ltd, Wallingford. The outcome of the meeting is a generalised curriculum covering the learning objectives and content of a module or course for engineers, followed by more detailed guidelines for syllabuses of courses/modules of various durations.

This document is the outcome of the above informal consultation meeting. The meeting procedures and working papers are available in the Planning, Management and Operation Unit, Division of Vector Biology and Control of the World Health Organisation in Geneva. The list of working papers is given in the Appendix.

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* In this document, the term engineer refers to civil, sanitary/public health, hydraulic, irrigation and agricultural engineers, all of whom may be involved in WRDPs.

1. Introduction and Objectives

It is recognised that WRDPs in hot climates can and often do adversely affect human health through the increased prevalence of vector borne diseases. Among the range of disease vector control measures which can be applied in these projects, are aspects of environmental management with which engineers should be particularly involved. It is important to point out that most of the EM measures for reducing the health hazards of WRDPs are consistent with good engineering practices and hence are cost-effective. Although the use of such techniques is perhaps most feasible in major WRDPs, the need for appropriate control measures in smaller-scale projects should not be overlooked. Unfortunately many engineers involved in WRDPs are unaware of the adverse health impacts of their projects, and they lack training in the use of EM as part of disease vector control strategies.

The purpose of this document therefore is to propose a curriculum of study on this subject appropriate to engineers. In particular an attempt is made to produce:

a) a curriculum on disease vector control in WRDPs suitable for inclusion in engineering courses;

b) guidelines for construction of syllabuses in relation to the proposed curriculum.

In the context of this document a **curriculum** is taken to mean the learning objectives and content of a course or module of study, while a **syllabus** contains in addition full detail on times, teaching methods, resources, and evaluation methods.

Attention is focussed on professional level (i.e. undergraduate, postgraduate, and in-service post qualification) training, and four different durations of course or module were considered.

2. Proposed Curriculum

2.1 Approaches

The methodology of curriculum development adopted in the consultation and in this publication consists of three stages. The first is the identification and description of the problem (i.e. the adverse health consequences of WRDPs) which has necessitated changes or additions to existing engineering curricula. This has been done in the background papers to the consultation and also in the wider literature.

The second stage is to establish learning objectives for any proposed changes or additions to existing engineering curricula. These consist of desired outcomes in terms of skills to be acquired or knowledge to be gained by students. Learning objectives are presented below in Section 2.2.

The third stage is the formulation of the curriculum content required to achieve the stated learning objectives (Section 2.3).

The fourth stage is the integration of the proposed curricula into existing engineering programmes. This can only be done by the individual education and training institutions which adopt the proposals made in this publication.

Finally the curriculum is further developed by setting out more detailed guidelines for the teaching of the proposed material. This includes a consideration of teaching methods, content of individual lectures, practicals, visits and seminars, and resources needed (Section 3).

The learning objectives, proposed curriculum content and syllabus guidelines are set out in such a way as to be applicable to a course or module of any duration from 5 hours to six weeks. The guidelines for use of the curriculum (Section 2.4 and 3) in fact consider four course or module durations, 5h and 10h, corresponding to undergraduate and postgraduate modules, and 35h and 205h, corresponding to one week and 6 week full time short courses.

The curriculum focusses particularly on the role of the engineer in disease vector management, and indeed this topic is allotted a separate heading within the curriculum. The curriculum is divided into sections, namely:

- Experience from WRDPS (i.e. case studies)
- Diseases
- Vectors
- Control Methods
- Role of the Engineer

In practice, in a particular syllabus these should be taught in an integrated way; it is however convenient to consider them separately from the point of view of the overall curriculum and the syllabus guidelines.

In view of the importance of malaria and schistosomiasis, the curriculum focusses especially on these two diseases. Other infections are mentioned but they would not be detailed unless of special local importance.

It is recognised that many engineers undertaking such a course may lack basic biological knowledge and be unfamiliar with the specialised terminology used. Institutions adopting the proposed curriculum should be aware of this problem and modify their teaching style according to their students' needs, perhaps by the provision of glossaries or by including additional introductory lectures.

2.2 Learning Objectives

Whether one is dealing with a self contained short course or a module within an engineering degree programme, the learning objectives of the curriculum should be substantially the same.

The objectives of the course or module are to give the student or practising engineer:

(i) An understanding of the impact of WRDPs on vector borne water related diseases.

(ii) Knowledge of the vector biology and disease transmission, geographical distribution, present status and clinical features of the major diseases (Malaria and Schistosomiasis in particular) of WRDPs.

(iii) Knowledge of the life cycle and ecology of the major vectors and impact of environmental changes on their preferred habitats in WRDPs (mosquitoes and snails in particular).

(iv) An understanding of the major disease vector control methods in use, with special emphasis on environmental management measures.

(v) An appreciation of the role of the engineer in relation to his own engineering tasks, in relation to professionals of other disciplines, and also in personal protection and the protection of site staff.

In a course of six weeks' duration, the following additional objectives would apply to a potential designer or participant in disease vector control programmes: that such a person should obtain sufficient detailed knowledge and experience of:

- Disease vectors and vector survey techniques
- Principles of disease epidemiology and epidemiological survey techniques
- Major control methods and their problems
- Control programme management techniques

That he/she would be competent to:

(vi) Participate in planning and conduct of the necessary field surveys to establish a disease vector control programme in a new situation.

(vii) Promote the incorporation of EM measures in the design and operation of WRDPs.

(viii) Be a major participant in integrated disease vector control programmes.

2.3 Curriculum Content

A common curriculum is proposed for all four course/module lengths. The weighting between the five topics of the curriculum and the teaching methods vary for the four courses/modules (see Sections 2.4 and 3).

The proposed content is as follows:

2.3.1 Lessons from Experience of WRDPs

After surveying the historical role of engineers in VBD control, the following important lessons of experience should be conveyed by case studies/anecdotal material:

(i) that disease risk correlates with crops, cropping patterns and seasons.

Examples can be given of:

A Double cropped rice leading to double cropped malaria
B Cotton and malaria
C Sugar and schistosomiasis
D Bananas and schistosomiasis

(ii) Provision of safe drinking water causes a proportional decrease in schistosomiasis.

(iii) Health costs of new WRDPs can significantly offset expected benefits.

(iv) Unforeseen impacts of new WRDPs can be disruptive to society, economy, environment and health.

(v) Large projects cause large disruptions in society and health.

(vi) Flood control and good water management can also control diseases.

(vii) Intensification of cropping and irrigation can also cause intensification of silt, aquatic weeds, vectors and disease in canals.

(viii) Engineers may neglect drainage systems but mosquitoes and snails will not.

2.3.2 Diseases

1. **Life Cycles of Causative Agents** - Enumeration of the causative aspects of major vector borne diseases. Definition of parasitism. Life cycle of Plasmodium and Schistosoma; development in man and in vector/intermediate host.

2. **Clinical Features and Treatment** - Development of malaria parasite in man. Incubation, phases of the infection, clinical symptoms, pathogenesis, spectrum of clinical manifestations of the disease caused by various species of Plasmodia and Schistosoma, duration of infection, fatality. Diagnosis. Treatment, drugs in use, dosages, duration of treatment, drug resistance and rehabilitation of patient. Personal protection.

3. **Epidemiology** - Factors influencing transmission of the vector borne diseases.

   - Biological: reservoir of infection, vector, susceptible population, vectorial capacity.

   - Ecological: influence of temperature, relative humidity and rain pattern, transmission season, locality.

   - Socio economic and behavioural: man-vector contact, human dwellings, location, sleeping habits, occupational and domestic activities, migration, sanitary facilities and safe water supplies.

   Measurement of the disease in the population, incidence, prevalance, morbidity, mortality. Methodology of measurement: surveys, detection of cases, epidemiological analysis. Epidemiological indices, endemicity, epidemicity, parasite formula, classification of cases.

4. **Geographical Distribution** - Distribution of malaria and schistosomiasis in the world, original distribution of the parasite species, distribution of major vectors, diseases, prevalence and impact on health.

5. **Disease Control, Present Status and Perspectives** - Malaria, socio-economic impact, major periods of malaria control. Concept of malaria eradication, control and eradication methodology, achievements and failures, role of chemotherapeutic measures. Present status, parasite and vector resistance, inadequacy of health services, present control methodology, research. Impact of WRDPs on prevalence and distribution. Need for diversification of control methods.

   - Schistosomiasis: socio-economic impact, control methodology, antiparasite measures, snail control. Major problems confronting effective control; limitation of existing tools, lack of health services, sanitation status; need for diversification of control methods, current status of applied and basic research in schistosomiasis, prospects.

2.3.3 Vectors

Definition of "vector" and "intermediate host". The most important vectors related to water (mosquitoes and snails in particular).

Biology of mosquito: life cycle - eggs, larvae, pupa, adult. Heterotrophic insects. The differences between malaria vector and other species.

What type of water is suitable for mosquito breeding (e.g. standing, flowing, sunlit, shaded, clear, turbid).

Habitats of mosquitoes. Ecological factors: temperature, pH, light, salinity, depth, movement, chemical composition, vegetation. How all these factors influence the breeding of mosquitoes.

Adult mosquito - when and where they attack people. How to prevent contact. The most important species. Diseases which they transmit.

Biology and ecology of snails.

Habitats of snails.

How WRDPs create new vector habitats (reservoirs, dams, canals, irrigation system, new or expanded human settlements).

2.3.4 Control Measures

Historical background of vector control.

The techniques of vector control.

Chemical control - chemicals and equipment used for larviciding and adulticiding. Effect of chemicals on the environment; monitoring and safe use of pesticides.

Biological control - predators, parasites and pathogens.

Environmental control - source reduction, water management, weed control and cultural control; possible adverse effects of these practices on the environment.

Prevention and avoidance of disease by reduction of man-vector contact.

Comprehensive vector control through utilisation of all available methods in an integrated approach*.

2.3.5 Role of Engineer and other Professionals

Planning - Involves health specialists as well as engineers and agriculturalists to identify existing and potential health problems.

Design and construction - Assessment of appropriate environmental measures in relation to physical, ecological and social conditions in the project area. Important issues: many of the more effective control measures already form part of the physical works normally associated with water storage and control; many effective control measures are concerned with the standards of construction rather than with specialist features.

Operation and maintenance - A neglected area of development which leads to ineffective disease vector control. Opportunity to practise environmental manipulation.

Rehabilitation - Physical improvement strategies to WRDPs allows environmental control measures to be introduced to existing schemes.

Introduction to economics of health.

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* In this document, the expressions 'comprehensive' and 'integrated' vector control are considered to be interchangeable.

2.4 Time Matrix

Four lengths of course or teaching module have been considered. The breakdown of time between the five main topic headings is proposed as follows:

Table 1: Proposed Weighting of Curriculum Topics (Hours, Percentage)

Topic	Course or Module Duration (hours)			
	5	10	35	205
Case Studies	1h (20%)	2 (20)	7 (20)	32 (16)
Diseases	1 (20)	2 (20)	5 (14)	20 (10)
Vectors	1 (20)	2 (20)	11 (31)	66 (32)
Control	1.5(30)	3 (30)	10 (29)	80 (39)
Role of Engineer	0.5(10)	1 (10)	2 (6)	7 (3)

These figures are broken down in more detail in Section 3.

3. Guidelines for Syllabus Construction

3.1 Introduction

To construct a detailed syllabus from the general curriculum proposed in Section 2, full account must be taken of the background of the students, the amount of time available within the wider engineering curriculum, available teaching resources and the particular local VBD problems. It may be that alterations to the curriculum itself will be in order, although it is unlikely that these will be major.

Although it is possible to produce a generalised curriculum, it is not feasible to set out a universally applicable syllabus. However, the following sections offer guidelines towards the construction of syllabuses, the details of which can only be finalised by those who will actually teach courses.

The guidelines here follow the same subheadings as Section 2, enlarging upon the material which could or should be taught, and proposing the most desirable teaching methods.

3.2 Times and Teaching Methods

Tables 2-5 in this section set out for each of the four proposed course/module durations the amount of time which should be allocated to each topic and the way the time should be divided between different teaching methods.

3.2.1 Lessons from Experience of WRDPs

A course or module for engineers should begin with a review of the historical role of engineers in VBD control. The example of the Panama Canal could be used as a case study. Following this, the lessons identified in the curriculum (Section 2.3.1) could be conveyed by case studies as set out in Table 2 below.

Table 2: Syllabus Guidelines - Case Studies

Course/Module Duration (Hrs)	5	10	35	205	Case Study Location
Time Needed (Hrs)	1	2	7	32	
	(i)a*	(i)a	(i)a	(i)a	Yangtze Valley, China
		(i)b	(i)b	(i)b	Sudan Gezira
			(i)c	(i)c	Puerto Rico
				(i)d	St Lucia
		(ii)	(ii)	(ii)	Study Zone Blue Nile Health Project
	(iv)	(iv)	(iv)	(iv)	Kariba Dam Aswan Dam
				(v)	Lake Volta
				(vi)	Operation Riz Mali, Al Hassa Oasis, S. Arabia
	(vii)	(vii)	(vii)	(vii)	Sudan Gezira
			(viii)	(viii)	Leyte Project, Phillip-ines; Low-veld, Zimbabwe
Teaching Method	Slides, Anecdote	Slides, Relevant History,	Slides, Relevant History, Visiting Lectures	Slides, Relevant History, Visiting Lectures Practical Exercise	

* Roman numerals in the table refer to the lessons identified in Section 2.3.1.

3.2.2 Diseases

The material on diseases (malaria and schistosomiasis in particular) would ideally be broken down according to Table 3. The demonstrations and field visits which would be carried out in the 205h course are listed after the table.

Table 3: Syllabus Guidelines - the Diseases

Course/ Module Duration (Hours)	5	10	35	205		
Time Needed (Hours)	1	2	5	20		
Topic*	L	L	L	L	D	F
Life Cycle & Causative Agent	0.5	0.5	0.5	0.5	0.5	
Clinical Features & Treatment			0.5	1		
Epidemiology	0.5	1.5	2	6		3
Geographical Distribution			1	2		
Disease Control, Present Status & Perspective			1	2		5

* L-Lectures; D-Demonstration; F-Field Work.

3.2.3 Vectors

The study of vector biology, ecology, and habitats could be broken down as in Table 4 below.

Table 4: Syllabus Guidelines - the Vectors

Course/ Module Duration (Hours)	5	10	35			205		
Time Needed (Hours)	1	2	11			66		
Topic*	L	L	L	Lab	F	L	Lab	F
Medical Importance of Mosquitoes & Snails			1			4		
Mosquito Taxonomy Life Cycle Biology & Ecology		1	1	2		5	4	
Behaviour of Mosquito	1				2	4	4	24
Snail Taxonomy Biology & Ecology		1	1	1		7	4	
How WRDPs Create New Vector Habitats			1		2	2	4	4

* L-Lectures; F-Field Work.

The following listings offer more detail on the material to be covered.

(3.2.3 Vectors, contd.)

Material for Incorporation in 5h Module (Total Time on Topic - 1 hour)

Lecture:

1. Medical importance of arthropods and snails. Biology of mosquitoes. Ecology and behaviour. Biology and ecology of habitats of snails. How WRDPs create new habitats for vectors.

(1 hour)

Demonstration: slides, film, pictures.

Material for Incorporation in 10 h Module (Total Time on Topic - 2 hours)

Lectures:

1. Definitions of "vector" and "intermediate host". The most important vectors related to water (mosquitoes and snails in particular). Life cycle and habitats of mosquitoes.

(1 hour)

Demonstration: slides, pictures.

2. Biology and ecology of snails. The most typical habitats of snails. Medical importance. How WRDPs create new habitats of vectors and intermediate hosts.

(1 hour)

Demonstration: slides, pictures.

Material for Incorporation in Course of 35 Hours Duration (Total Time on Topic 11h)

Lectures:

1. Medical importance of arthropods and snails connected with water (mosquitoes and snails). Biology of mosquitoes. Life cycle - egg, larva, pupa, adult. Behaviour of mosquitoes.

(1 hour)

2. Habitats of mosquitoes. Ecological factors for development of mosquitoes - aquatic stage. Temperature, pH, light, salinity, depth, movement, chemical composition, vegetation. How they influence the distribution and density of mosquitoes.

(1 hour)

3. Biology and ecology of snails. Responses to water movement. Distribution. Population dynamics. Most typical habitats of snail.

(1 hour)

4. Entomological surveillance and techniques for vector survey. Survey of newly created vector habitats.

(1 hour)

Laboratory Demonstration:

1. Mosquitoes: eggs, adult, and larvae - Anopheles and other species. Taxonomy.

(2 hours)

2. Snails: eggs, adults.
Techniques for entomological survey.

(1 hour)

Field Visit:

To gain knowledge of habitats of mosquito and snails. Factors which tend to increase the density of vectors. Techniques for entomological surveillance.

(2 hours)

3. Visit and identify the vector habitats created by WRDPs

(2 hours)

Material for Incorporation in Course or Module of 205 h

(Total Time on Topic 66 hours)

Lectures (22 hours)

1. Introduction to arthropods and snails of medical importance. The most important vectors related to water. Geographical distributions.

(2 hours)

2. Mosquitoes and their Epidemiological Significance. Vectors of malaria. Life cycle - egg, larva, pupa, adult - Anopheles.

(2 hours)

3. Differences between malaria vectors and other species of mosquito (Culex, Aedes, etc.) Taxonomy. Mosquito identification.

(2 hours)

4. Ecology of mosquitoes. Ecological factors of aquatic stages: pH, light, salinity, depth, movement, chemical composition, vegetation. The influence of ecological factors on mosquito populations. (2 hours)

5. Habitats of mosquitoes related to WRDPs (dam, canals, drains, irrigation systems).

   (2 hours)

6. Behaviour of mosquito as a vector. Inside and outside resting places. Man-vector contact.

   (1 hour)

7. Technique for the determination of vector age, vector density, infectivity. Entomological surveillance and survey methods.

   (1 hour)

8. Medical importance of the snails. Biology of life cycle.

   (2 hours)

9. Behaviour of snails correlated with water movement, vegetation.

   (2 hours)

10. Population dynamics of snails. Ecological factors of habitats. Temperature, clarity, competition and predators.

    (2 hours)

11. Population dynamics of vectors affected by man-made changes in environment: irrigation, drainage, artificial reservoirs, agricultural practices.

    (2 hours)

12. Geographical distribution of snails with schistosome species.

    (1 hour)

13. Resistance to Insecticides

    (1 hour)

Laboratory Exercises - 16 hours

1. Life cycle of mosquito. Identificatio of anopheline mosquito larvae and adult.

   (4 hours)

2. Determination of vector age and infectivity, parasitic rate.

   (4 hours)

3. Life cycle of snails. Identification of snails as intermediate hosts.

   (4 hours)

4. Demonstration of different habitats by slides, films, pictures, etc.

   (4 hours)

Field Visits (4 days x 6 hours = 24 hours)

Visits to different types of habitats of mosquito and snail-irrigation systems, drainage, rice field, dam, cotton field, banana, sugar fields, reservoirs, etc. Techniques for entomological survey. Resting mosquitoes inside and outside, man-vectors contact. Distribution of larvae and snails.

Discussion (4 hours)

How WRDPs create new vector habitats. Methods to avoid this.

3.2.4 Control Measures

The material on control methods could be broken down according to Table 5 below and the listings which follow. The teaching approach is by lectures except where otherwise stated.

Table 5: Syllabus Guidelines - Control Methods

Course/Module Duration (Hours)	**5**	**10**	**35**	**205**
Time Needed (Hours)	**1.5**	**3**	**10**	**80**
Topic				
Historial Background			1	2
Chemical Control		1.5	1	2
Biological Control			1	2
Environmental Control	1.5		3	11
Prevention & Avoidance			1	2
Comprehensive Vector Control (Integrated Methodolgies)		1.5	1	4
Health Education			1	2
Vector Control Methods (General Review - Group Discussion)			1	3
Demonstrations of Equipment & Machinery				16
Special Problems (Individual Projects Assigned and Presented to Class)				36

(3.2.4 Control Measures, contd)

Material for Incorporation in 5h Module

Lecture - Review of currently available methods of vector control emphasising utilisation of all available methods in an integrated programme.

(1.5 hours)

Material for Incorporation in 10h Module

Lectures:

1.

A. Historical background of vector borne disease control efforts.

B. Vector control methods - chemical control. A discussion of chemicals and equipment used for control of mosquitoes and snails.

C. Vector control methods - biological control. A discussion of the various predators, parasites and pathogens in current use against vectors.

(1.5 hrs)

2.

A. Vector control methods - Environmental management. A discussion of the various methods of source reduction, water management, weed control, drainage and filling as they may be applied to reservoirs, irrigation systems and other water development projects.

B. Integrated methodologies for vector control. A discussion of the use of all available methods in an integrated programme including personal protection, avoidance of man vector contact, drug treatment, and the need for health education.

(1.5 hrs)

Material for Incorporation in 35h Course/Module

Lectures:

1. Historical background of vector borne disease control efforts. (1 hr)

2. Vector control methods - a discussion of prevention and avoidance of diseases through reduction of man-vector contact. (1 hr)

3. Vector control methods - chemical control: A discussion of chemicals and equipment used for control of mosquitoes and snails. (1 hr)

4. Vector control methods - biological control: A discussion of the various predators, parasites, and pathogens, in current use against vectors. (1 hr)

5. Vector control methods - environmental management: A discussion of the various source reduction, water and weed management methods applicable for control of mosquitoes and snails in reservoirs. (1 hr)

6. Vector control methods - environmental management: A discussion of the various source reduction, water and weed management, and cultural control methods applicable for control of mosquitoes and snails in irrigation systems and drainage projects. (1 hr)

7. Vector control methods - Environmental management: A discussion of ways and means of preventing and avoiding vector borne diseases in connection with the settlement or resettlement of populations due to water development projects. (1 hr)

8. The need for health education of the project staff and a public relations and education programme for the labourers and nearby villagers. (1 hr)

9. Integrated methodologies for vector control: A discussion of the use of all available methods in an integrated programme. (1 hr)

Material for Incorporation in 205h Course/Module

1. History of vector borne disease control efforts - Lecture 2 hours.

2. Vector control methods - a general discussion of the currently available methods applicable to water resource development projects and basis of selection of such methods - Lecture and discussion 3 hours.

3. Vector control methods - a discussion of prevention and avoidance of disease through reduction of man-vector contact - Lecture 2 hours.

4. Vector control methods - chemical control: a discussion of chemicals and equipment used for larviciding - Lecture 2 hours.

5. Vector control methods - biological control: a discussion of the various predators, parasites and pathogens in current use against vectors - Lecture 1 hour.

6. Vector control methods - biological control: a discussion of other methods of potential future value but currently in various stages of research and development - Lecture 1 hour.

7. Vector control methods - environmental control.

Methods applicable to reservoirs

i. Manipulation of water level
ii. Spillway design to deter blackfly larvae
iii. Straightening of shoreline
iv. Filling and drainage of shoreline
v. Clearing of trees and brush prior to inundation
vi. Prevention of human and animal access to shoreline
vii. Biological control of vectors
viii. Clearing of floating debris
ix. Shading or exposure of shoreline habitats

(4 hours)

8. Methods applicable to irrigation systems

i. Rapid flow in canals
ii. Removal of aquatic vegetation
iii. Dredging of silt and vegetation
iv. Biological control of vegetation and vectors
v. Elimination of night storage
vi. Crop selection
vii. Design of water control structures
viii. Improved water control to avoid spillage
ix. Physical limitation of human contact with water
x. Water conservation by irrigation methods
xi. Flow interruption

(4 hours)

9. Methods applicable to settlement or resettlement of populations

i. Location of communities relative to surface water
ii. Provision of domestic water supply
iii. Housing facilities and protection of eating and sleeping areas
iv. Modified labour practices in irrigation systems
v. Excreta disposal facilities
vi. Localised drainage for rainfall
vii. Livestock management

(1 hour)

10. Methods applicable to drainage projects

i. Adequacy of drainage design
ii. Maintenance programme for drains
iii. Flushing systems
iv. Subsurface drainage

(2 hours)

11. The need for health education for project staff and the role of public relations and education. (2 hours)

12. Integrated methodologies for vector control - group discussion. (4 hours)

13. Special problems. Each student to propose a vector borne disease control programme to cope with a potential disease problem in connection with a planned water resource project in a hypothetical country. Problem to be presented after general discussion of vector control methods - Lecture 2 (12-36 hours)

14. Demonstration of equipment. (8-16 hours)

3.2.5 Role of Engineer and Other Professionals

Ideally the material outlined in the curriculum on this topic should not be taught separately, but rather be integrated fully into the remainder of the course or module. Opportunities can be made to discuss it more explicitly, especially in the longer courses when individual or group project work is being reviewed. Emphasis in that case should be put on the use of good engineering in VBD control and also on the role of the engineer vis-a-vis other professions.

3.3 Resources

The resources necessary to implement the courses or modules which have been discussed comprise:

- teaching staff
- publications and audio-visual aids
- demonstration materials and equipment
- field sites

These are considered in this section.

Staff

Where it is possible to use specialist staff to teach the major topics of the curriculum, the following would be the ideal qualifications:

Case Studies

Preferably teachers of engineering or public health, also possibly geography, ecology or history who have broad interests across fields of engineering and health in the tropics. Case studies could be supplemented by visiting lecturers who are engineers or health professionals associated with the project.

Diseases

Epidemiologist, MD with PhD or MPH specialised in epidemiology from national Headquarters of Malaria/Schistosomiasis control or School of Public Health or Chair of Community/Preventive Medicine.

Vectors

Entomologist, MSc, PhD or MPH specialised in medical entomology. Ecologist, MSc, PhD, specialised in Mollusca.

Control

Staff may be drawn from schools of Public Health or Tropical Medicine, local or national mosquito and vector control programmes or from national malaria, and other vector borne disease control programmes.

Publications and Audio Visual Aids

The following reference materials and audio visual aids have been identified as especially useful for the proposed curriculum. Additional references may be found in the bibliographies of some of the working papers.

Case Studies

1. "Irrigation and Health" to be published by ILRI of Wageningen, Netherlands, editor J. De Wolf, 1987. Contains material on all case studies except Al Hassa Oasis in Saudi Arabia (for which see 2 below).

2. Bahar, R. "The Impact of Alternative Engineering Practices in WRDP on Cost-Effectiveness of Vector Control Program PMO/PE/WP/86.7" Sixth Annual Meeting of PEEM.

3. TVA experience in mosquito control. Recent summary reports from Dr. R. Brooks, Division of Air and Water Resources, Tennesseee Valley Authority, Knoxville, Tennessee, USA.

4. Film on Blue Nile Health Project from EMRO of WHO, Alexandria, Egypt.

Diseases

1. Essential Malariology by L.V. Bruce-Chwatt, William Heinkeman Medical Books London, 2nd Edition, 1985.

2. Chemotherapy of Malaria by L.V. Bruce Chwatt (Ed), R.H. Black, C.J. Canfield, D.F. Clyde, W. Peters, W.H. Wernsdorfer, 2nd Edition, WHO Geneva, 1986.

3. Malaria Control as Part of Primary Health Care, Report of WHO Study Group, Technical Report Series No. 712, WHO Geneva, 1984.

4. WHO Expert Committee on Malaria 18th Report, Technical Report Series No. 735, WHO Geneva, 1986.

5. Schistosomiasis: Epidemiology and Control by Peter Jordan and Webbe, 2nd Edition, Blackwell, London, 1983.

6. Audio-visual material, set of slides on malaria, schistosomiasis, onchocerciasis and filariasis from WHO, Geneva.

Vectors

1. Manual on Larval Control Operations in Malaria Programmes, WHO, 1975.

2. The Control of Schistosomiasis, WHO, TRS, 788, 1985.

3. Environmental Management for Vector Control, WHO, TRS, 649, 1980.

4. Ecology and Control of Vectors in Public Health, WHO, TRS, 561, 1971.

5. Manual on Environmental Management for Mosquito Control with Special Emphasis on Malaria Vectors. Geneva, WHO, 1982 (Offset Publication, No. 66).

6. Brown, A.W.A. and Pal, R. Insecticide Resistance in Arthropods, 2nd Edition, Geneva, WHO, 1971, No. 38.

7. Covell, G. Notes on the Distribution, Breeding Places, Adult Habits and Relation to Malaria of the Anopheline Mosquitoes of India and the Far East. Indian Journal of Malariology, 16: 521-565 (1962).

8. Elliott, R. The Influence of Vector Behaviour on Malaria Transmission. American Journal of Tropical Medicine and Hygiene, 21: 755-763, (1972).

9. Service, W.W. Mosquito Ecology: Field Sampling Methods. Barking, Essex, Applied Science Publishers, 1976.

10. WHO. Manual on Practical Entomology in Malaria, Part I, Vector Bionomics and Organisation of Anti-Malaria Activity. Part II. Methods and Techniques, Geneva, 1975, (Offset Publication, No. 13).

Control Measures

1. WHO, "Manual on Environmental Management for Mosquito Control with Special Emphasis on Malaria Vectors", Geneva, 1982, (Offset Publication, No. 66).

2. Panel of Experts on Environmental Management for Vector Control (PEEM), Reports of the First, Second, Third and Fourth Meetings, PEEM Secretariat, WHO, Geneva, 1981-1984.

3. WHO, "Manual on Larval Control Operations in Malaria Programmes", Geneva 1973, (Offset Publication No. 1).

4. World Health Organisation, "Manual on Personal and Community Protection Against Malaria", Geneva, 1974, (Offset Publication, No. 10).

5. Laird, M. and Miles, J.W. (Editors), "Integrated Mosquito Control Methodologies, Vol. 1, Experience and Components from Conventional Chemical Control", Academic Press, 1983.

6. American Mosquito Control Association, "Biological Control of Mosquitoes", Bulletin No. 6, 1985.

7. Laird, M. and Miles, J.W. (Editors). "Integrated Mosquito Control Methodologies, Vol. 2, Biocontrol and other Innovative Components, and Future Directions", Academic Press, 1985.

8. World Health Organisation, "Biological Control of Vectors of Disease", (Technical Report Series No. 679), Geneva, 1982.

9. Herms, W.B. and Gray, H.F. "Mosquito Control: Practical Methods for Abatement of Disease Vectors", Commonwealth Fund, New York, 1944.

10. Tennessee Valley Authority/U.S. Public Health Services, "Malaria Control on Impounded Water", Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1947.
Out of print, but recent summaries are available from TVA, Knoxville, Tennessee, (Dr R Brooks).

11. Ansari, N. "Epidemiology and Control of Schistosomiasis", WHO, 1979.

Demonstration Materials and Equipment

Live and prepared samples of malaria parasites, schistosome eggs, mosquitoes, and snails may be obtained from the national headquarters of malaria and schistosomiasis control authorities.

Chemicals and equipment may be made available for demonstration by commercial companies.

Field Visits

Field visits should be made ideally to malaria and schistosomiasis control programmes. Where this is not possible, some value may be found in visiting pest mosquito control programmes, or public health laboratories where relevant work is being undertaken.

3.4 Evaluation

The evaluation of a curriculum and of the students studying it is an important aspect of curriculum development. Attention here is focussed particularly on the evaluation of the students' understanding.

Perhaps the most effective method of evaluation is to involve students in problem solving exercises using real or hypothetical case studies. Individual or group project work should be done, especially during longer courses. In this students would propose control strategies, clearly identifying the tasks of engineers and their roles in relation to other professionals. Ideally the problems or projects should be selected early in a course so that students use the teaching sessions to actively seek out information. At the end of the course the students' reports can be presented verbally to the class or in written form and assessed appropriately.

APPENDIX

LIST OF WORKING PAPERS

Informal Consultation for the Development of a Curriculum and Syllabus on Disease Vector Management in Water Resources Development Projects for Inclusion in Engineering Courses.

Agenda Item No.	Title and Author	Reference Numbers
3	Introduction: the Purpose and Objective of the Meeting by **R Bahar**	INF/CON/CUR/Eng. 01
4	Health Problems Related to WRDPs with Special Reference to Vector Borne Diseases by **V Orlov**	INF/CON/CUR/Eng. 02
5	Impact of Environmental Changes in WRDPs on Transmission of Vector Borne Diseases by **T Hristova**	INF/CON/CUR/Eng. 03
6	Review of Principal Disease Vector Control Measures Applicable in WRDPs by **E Smith**	INF/CON/CUR/Eng. 04
7	Review of Environmental Management Measures Applicable in WRDPs and the Role of Engineers in Their Application by **W R Jobin**	INF/CON/CUR/Eng. 05
8	The Role and Responsibilities of the Training Institutions for Training Engineers in the Promotion of Environmental Management through Engineering Methods for Disease Vector Control by **R C Carter** and by **A Mesdaghinia**	INF/CON/CUR/Eng. 06 INF/CON/CUR/Eng. 06.1

9	Proposed Curriculum on Disease Vector Management in WRDPs for Inclusion in Engineering	
	by **R C Carter** and	INF/CON/CUR/Eng. 07
	by **A Mesdaghinia** and	INF/CON/CUR/Eng. 07.1
	by **T Hristova** and	INF/CON/CUR/Eng. 07.2
	by **E Smith**	INF/CON/CUR/Eng. 07.3
10	Preparation of Guideline for Construction of Syllabus on the Basis of Proposed Curriculum by **W R Jobin**	INF/CON/CUR/Eng. 08

These papers are available from Planning, Management and Operation Unit, Division of Vector Biology and Control, WHO, Geneva.